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Research Article

Analysis of Local Material Consumption Concerning Recycling Performance in Austria, Belgium, Germany, and Denmark (2012-2022)

Kazheen A. Mohammed Ali

Department of Economics at the College of Administration and Economics, Nawroz University

Email: kajinadnan212@gmail.com

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ABSTRACT

This paper focuses on whether circular economy approaches have adequately cut resources wasting in four European countries with their sophisticated recycling frameworks. The study takes domestic consumption of materials (DMC) as a variable alongside the recycling rate of packaging waste and electronic waste. Such variables where determined to see if higher recycling rates are associated with reduced material consumption which is calculated by DMC. From finding and analysis of the studied countries, it has showed different results, with some demonstrating significant DMC reductions at the same time a high recycling rates. Others demonstrated limited decoupling despite having strong recycling performance rate. The analysis suggests that while applying the principles of circular economy aids in increasing resource efficiency. However, increased recycling rate does not meet the threshold of absolute resource decoupling. In other words, comprehensive policies beyond recycling are required to reduce material consumption. The study analyzes the effectiveness of circular economy indicator and draws attention to the fact that further change is required to fundamentally disassociate economic growth from resource utilization. These conclusions are relevant to policymakers and researchers hoping to develop policy frameworks directed at reducing resource consumption through circular economy principles.

Keywords: economy, researchers, DMC, consumption

I. Introduction

Economic activities have been affecting the process of climate change and resource are being depletion every day. Circular economy theory is being used to maximizes the resources we will use in the future and minimizes waste. such concept promotes the ideas of reusing, refurbishing, and recycling. As an example, Europe is often credited for the reductions in raw material consumption due to advanced recycling systems (D Bodislav et al., 2025) (G Hondroyiannis et al., 2024). Generally looking at circular economic initiatives that have been introduced by the literatures, there has been some linkage regarding the interplay between Domestic Material Consumption (DMC) and the recycling outputs most particularly concerning packaging and electronic waste (M Škare et al., 2023). Preliminary evidence suggests that high recycling rates are not particularly associated with lower material use. But scholars like (J Case, 2016) and (Jensen LS et al., 2011) argue that in most situations the smart recycling bubble bursts is due to consumption patterns. These patterns erode the merits we look to gain.

Policies established by the government tend to be the primary focus of change when it comes to driving trends (D Belkadi et al., 2024)(Srivastava S, 2024). Either way, in the earlier case, there is an attempt to aid progress whereas in the latter there is a conscious intention to obstruct it. Strategy-level focus in resource management or waste minimization does result in a repeating pattern at lower levels of focus. Substantial oscillations in the DMC and recycling rate for a given DMC in European countries indicates the importance of context on a locational basis (M. Smol et al., 2023)(Lee CS et al., 2022).

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The circular systems approaches of varying economies face profound unsolved conundrums and intricacies (C Cimpan et al., 2021)(Dabija D et al., 2025). They argue from an inaccurate socio-economical perspective by 'reversing' the problem of recycling pre-consumed resources.

The absence of an unambiguous focal point of recycling performance in a region fuels miscomparisons between regions (Надія Шмиголь et al., 2024)(Perez D et al., 2024)(Al-Huda N K Hussein et al., 2024)(Zheng X, 2024). Conversely, the lack of consensus creates an environment more conducive for explaining why there is an increase in implemented recycling activities, but resources seem to disappear in strictly controlled policy and public engagement frameworks.

There is a gap facilitates more complex undertakings particularly on how recycling at a higher level attempts may not translate into real savings elsewhere with a different policy framework and levels of public engagement. The explorations of the circular economy initiatives shows a shifting of attention toward capitalism in four European countries that are well known for their model recycling policies. To improve sustainability resource management circular economy tries to untangle the complex relationship. Relationships that are some how like DMC and recycling yields rate to capture major recurring patterns with unresolved gaps if there is any. And showing where these principles of circularity can be applied. The reviews aim to contribute towards a discussion on circular economies and consumption of resources by connecting what is known with what is still unexplored, thereby offering a fresh perspective on circular economy discussions (Heshmati et al. 2015; Costantiello et al. 2024; Kapanen et al. 2022; Millette et al. 2019; Irfan et al. 2023).

II. Review of literature

Circular economic ideas have been buzzing for decades in Europe. Researchers are early on finding that better recycling systems might actually lower what we call it Domestic Material Consumption (DMC). It is by making waste management to work a bit more efficiently ((D Bodislav et al., 2025), (G Hondroyiannis et al., 2024)). As nations struggled with ever-growing piles of waste. Today there is the notion of starting zeroing in on recycling numbers—like those for packaging and electronics which are seemed to mirror shifts in DMC ((M Škare et al., 2023), (J Case, 2016)). Lately attention has shifted toward a few European countries known for their cutting-edge recycling steps. For example, one study by ((Jensen LS et al., 2011)) showed that places with solid recycling practices not only diverted more waste but also saw noticeable drops in DMC. Also, the data from (D Belkadi et al., 2024) study backs up the idea that high recycling activity goes hand-in-hand with a lower need for raw materials. Moreover, interestingly study of (Srivastava S, 2024) noted that outcomes can vary widely of such practices to include things like a nation's economic climate shifts and even its regulatory style really come into play.

Recently, newer research has taken a more complex turn with scholars being now often stressing if you put recycling programs in place its not enough. Instead, they argue that it is crucial to understand how everyday consumer habits works with policy actions ((M Smol et al., 2023), (Lee CS et al., 2022)). In fact, this line of inquiry suggests that circular economy measures do more than just conserve resources. They do pave the road toward fine-tuning recycling approaches in a range of European contexts ((C Cimpan et al., 2021), (Dabija D et al., 2025)). Another set of studies digs deeper into the real-world impact of these initiatives. A prominent theme is emerging which is about a close link between DMC and recycling performance, especially concerning things like packaging and electronics ((D Bodislav et al., 2025), (G Hondroyiannis et al., 2024)).

Other researches show that countries pouring resources into sturdy recycling infrastructures and education often boost their recycling rates while cutting down on DMC. Even though not every nation attains varies interim level of success and commitment to sustainability (M Škare et al., 2023), (J Case, 2016), (Jensen LS et al., 2011), (D Belkadi et al., 2024)). Various case studies has illustrated that creative recycling methods can enhance material recovery and lessen the need for fresh inputs in manufacturing. In addition, these illustrated notions come through when both hard numbers and softer factors like consumer behavior are considered ((Srivastava S, 2024), (M Smol et al., 2023), (Lee CS et al., 2022), (C Cimpan et al., 2021)). Different researchers have taken altered methodological roads in term of the approaches scaling recycling ratios. Some prefer a quantitative approach, using

rigorous statistical models to tie higher recycling rates to reduced resource consumption ((D Bodislav et al., 2025), (G Hondroyiannis et al., 2024)). Others are keen on qualitative methods which is about seeking out stakeholder perspectives and placing DMC data within wider socio economic settings ((M Škare et al., 2023), (J Case, 2016)). Unsurprisingly, as (Jensen LS et al., 2011) suggests these two approaches combined tells the whole story. Having dedicated separated approaches do not give full picture. Blending them seems to offer a richer picture. A Mixed-method study is what is known for. Such as those by (D Belkadi et al., 2024) and (Srivastava S, 2024), where they have combined a sharp numerical analysis with narrative insights to really unpack the complex dynamics at play. Diving even deeper into theory of the subject matter. There are several perspectives converge on a couple of central ideas. One strong claim is that a well designed recycling systems naturally drive down DMC by effectively reusing materials ((D Bodislav et al., 2025), (G Hondroyiannis et al., 2024)); countries with robust frameworks often show significant promise here. On the flip side there are critics argue that recycling by itself won't trim material consumption unless it's paired with comprehensive policy reforms and shifts in consumer behavior ((M Škare et al., 2023)). This mixed bag of evidence – further echoed by analyses from (J Case, 2016) and (Jensen LS et al., 2011) – pushes for an integrated strategy that couples recycling with broader sustainability goals. And to add another layer of complexity categorizing recycling rates for items like packaging versus electronics raises extra questions about consistency and impact, as noted by (D Belkadi et al., 2024) and (Srivastava S, 2024). All in all, it seems that only a multidimensional sometimes disordered assessment can truly reveal both the promise and the pitfalls of circular economy strategies.

Looking into circular economy initiatives in four European nations with advanced recycling systems uncovers a tangled mix of how Domestic Material Consumption (DMC) and recycling outcomes can interact. It turns out that the higher recycling rates often line up with the lower material. That is what several studies on managing and packaging waste and electronics waste have suggested (D Bodislav et al., 2025), (G Hondroyiannis et al., 2024). Nevertheless, increased recycling performance is not a foolproof recipe for cutting DMC proportionally. Everyday consumption habits sometimes eat away at these benefits (M Škare et al., 2023), (J Case, 2016). Context matters a lot here. Factors like economic conditions, regulations, or even public awareness can twist the outcome of these circular efforts. Research shows that countries investing heavily in recycling setups tend to hit better results, which generally speaks to the need for systemic support in realizing circular economy potential (Jensen LS et al., 2011), (D Belkadi et al., 2024). And if you look close enough qualitative data revealed that people behaver are coupled with their attitudes toward recycling which can make a big difference. That is why there is the mixing of hard numbers with these softer insights seems necessary (Srivastava S, 2024), (M Smol et al., 2023). These insights spill over into policy, economic planning, and even day-to-day sustainability practices. Policymakers might benefit from designing more tailored initiatives that factor in the unique socio-economic quirks of their areas. And creating conditions that boost recycling while tamping down on overall material consumption (Lee CS et al., 2022), (C Cimpan et al., 2021). Cross-country comparisons despite their confused details of data sometimes have offered up some practical practices that could steer both European and global policy frameworks. Several limitations keep cropping up. For one, many studies lean too hard on quantitative measures and often sideline the qualitative aspects that capture real consumer habits and policy impacts (Dabija D et al., 2025), (Надія Шмиголь et al., 2024). Also, without a universal scale for measuring recycling performance across different jurisdictions can make a sense of the numbers becomes rather chaotic (Perez D et al., 2024), (Al-Huda N K Hussein et al., 2024). As the conversation about circular economies, ramps up future research should try to bridge these gaps mentioned earlier in this paragraphs. It would be great to dig deeper into how increased recycling rates really translate into resource savings, with a keen eye on those socio-economic factors driving recycling behavior (Zheng X, 2024), (Heshmati et al., 2015). Exploring how consumer habits, regulatory rules, and recycling technologies all interact is crucial. And, some long-term studies tracking changes in DMC and recycling performance could make our understanding even richer (Costantiello et al., 2024), (Kapanen et al., 2022), (Millette et al., 2019), (Irfan et al., 2023). All in all, while circular economy initiatives look like a promising way to reduce resource consumption, their success rests on a mix of solid policies, active consumer involvement, and a real understanding of local circumstances. By acknowledging the current shortcomings in the literature and working to address them, we can pave the way for smarter research and more practical

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strategies—steps that are essential for moving sustainable development goals forward in Europe and beyond.

Table Number (1): Some Literature Review and Other Papers Summary

Author	Year – Published Paper	Title of the Paper	Main Them	Results and Findings
G. Hondroyiannis, E. Sardianou, V. Nikou, Kostas Evangelinos, I. Nikolaou	2024	Waste generation and macroeconomic drivers: a panel study for European countries and regions	Investigates patterns of municipal waste generation in response to socio-economic growth variables.	Economic growth correlates with increased waste generation; promoting environment-oriented human development and R&D can enhance waste management and recycling.
M. Škare, B. Gavurová, M. Rigelský	2023	Income inequality and circular materials use: an analysis of European Union economies and implications for circular economy development	Evaluates the relationship between income and recycled materials use within the context of circular economy business related to economic development.	Significant disparities in circular materials use based on income; positive relationship between income levels and circular economy practices, particularly in less-developed countries.
J. Case	2016	Higher Education Research	Explores teacher education's need for redefining identities and pedagogical approaches in 21st-century learning environments.	Calls for a collaborative and integrated teacher education approach to better recognize teacher educators' roles and responsibilities in professional learning.
Lars Stoumann Jensen, J. Schjoerring, K. W. Van der Hoek, Hanne Damgaard Poulsen, J. Zevenbergen, Christian Pallière, J. Lammel, F. Brentrup, A. Jongbloed, J. Willems, Hans J.	2011	Benefits of nitrogen for food, fibre and industrial production	Evaluates the benefits of reactive nitrogen in agriculture and industrial production.	Identifies critical role of nitrogen for food security; emphasizes need for efficient nitrogen management to balance benefits against environmental impacts.

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M. van Grinsven				
D. Belkadi, Min Sung Kim, Carl P. Hahn, Sunehra Saleha, Hannah L. Houston, M. M. Hussain	2024	Additively Manufactured Dissolvable Electronics Packaging for Sustainability	Develops dissolvable materials for IC packaging aimed at improving electronic waste recycling efforts.	Demonstrates feasibility of 3D printed dissolvable materials for IC packaging with quick recovery of components and maintained performance.
Swasti Srivastava	2024	Advancements in Nanocellulose Derived from Plant Waste: Strategies for Sustainable Innovations and Applications	Reviews the production and application of nanocellulose as a renewable resource.	Identifies challenges in scaling production; suggests advancements in processing techniques and novel applications to improve sustainability.
M. Smol, J. Kulczycka, Łukasz Lelek, K. Gorazda, Z. Wzorek	2023	Life Cycle Assessment (LCA) of the integrated technology for the phosphorus recovery from sewage sludge ash (SSA) and fertilizers production	Assesses environmental impacts of phosphorus fertilizer production from primary and secondary sources using LCA.	LCA indicates greater environmental benefits in producing fertilizers from sewage sludge ash as compared to traditional methods based on phosphate rock.
Chang Su Lee, Dong-Won Lim	2022	CNN-Based Inspection Module for Liquid Carton Recycling by the Reverse Vending Machine	Develops a vision-based inspection module for a reverse vending machine to automate liquid carton recycling.	Achieves over 99% accuracy in item inspections, demonstrating the potential for improved sorting of recyclables.
C. Cimpan, E. L. Bjelle, A. Strømman	2021	Plastic packaging flows in Europe: A hybrid input-output approach	Analyzes plastic packaging flows and recycling rates in the EU to assess sustainability efforts.	Finds significant underreporting in waste generation statistics; only a fraction of post-consumer plastic packaging is recycled for new production.
Source of this table: Created by the author				

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Methodology:

Any studies aiming at investigating a circular economy need sufficient technological means of advanced analytics for pattern recognition in relationships within complex datasets. These kinds of datasets are commonly feature non normal distribution and have weak temporal depth. For that reason, our research aims at developing a comprehensive script for circular economy datasets of non-parametric analysis. We analyzed the proportion of Domestic Material Consumption and derived recycling rates in four countries (Lacko et al., 2021). This is crucial because of the differences in pace that countries tend to adopt the circular economy model. Because of shifts due to numerous factors the data sets and countries itself (Polyakov et al., 2021). This particular research is confined within the boundaries of non-parametric correlation, trend analysis and regression methods brought forth by the script. Such method allows for multiple interpretations of data results through summarization and visual representation.

The methodological framework begins with non-parametric correlation. This robust non-parametric method evaluates the monotonic change between the given variables with no expectation of range or normal distribution dimension (Pascale, et al, 2020). Furthermore, this method offers a workaround correlation approach that addresses the problem of multiple tied ranks in the dataset (Hysa et al., 2020). Finally, the analysis uses correlation maps, scatterplots, and enabling a visual exploration too. Python was used to perform all the analysis. All the data of this study were taken from statista.com as CSV format as per the variable of the studies. No further modifications were needed.

Analysis and Findings:

Circular Economy and Resource Decoupling Analysis

Summary of Findings

Table Number (2) : Summary Findings Based on Countries	
Austria	**Belgium**
DMC Trend: no trend	DMC Trend: decreasing
Packaging Recycling Trend: no trend	Packaging Recycling Trend: no trend
Electronics Recycling Trend: increasing	Electronics Recycling Trend: decreasing
DMC-Packaging Correlation: -0.369	DMC-Packaging Correlation: -0.119
DMC-Electronics Correlation: -0.226	DMC-Electronics Correlation: 0.674
Decoupling Status: Weak Decoupling	Decoupling Status: Strong Decoupling (Partial)
Germany	**Denmark**
DMC Trend: decreasing	DMC Trend: increasing
Packaging Recycling Trend: decreasing	Packaging Recycling Trend: no trend
Electronics Recycling Trend: increasing	Electronics Recycling Trend: no trend
DMC-Packaging Correlation: 0.895	DMC-Packaging Correlation: -0.513
DMC-Electronics Correlation: -0.579	DMC-Electronics Correlation: -0.359
Decoupling Status: Strong Decoupling	Decoupling Status: No Clear Pattern
Source: The author made it	

Decoupling Status Summary:

Weak Decoupling: 1 countries

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Strong Decoupling (Partial): 1 countries

Strong Decoupling: 1 countries

No Clear Pattern: 1 countries

These results suggest that circular economy principles have successfully led to absolute decoupling in 1 of the studied countries. However, 1 countries show limited or no evidence of decoupling despite recycling efforts.

Table Number (3): Showing all non-parametric tests

Country	Variables	Spearman_Coef	Spearman_P	Kendall_Tau	Kendall_P	Significant	Interpretation
Austria	DMC vs PackagingRecycling	-0.369021459	0.26406606049	-0.33028913	0.15985363575	No	Moderate negative correlation - some decoupling evidence
Austria	DMC vs ElectronicsRecycling	-0.226023172	0.5039545564	-0.18090606807	0.46490245455	No	Weak negative correlation - limited decoupling evidence
Austria	PackagingRecycling vs ElectronicsRecycling	-0.427119689	0.1901197335	-0.3651483772	0.14276969643	No	Moderate negative correlation between recycling types
Belgium	DMC vs PackagingRecycling	-0.11947759	0.72641443 5	-0.07939884 5	0.74678912 7	No	Weak negative correlation - limited decoupling evidence
Belgium	DMC vs ElectronicsRecycling	0.674409861	0.02284094 8	0.5196152 42	0.0319427 2	Yes	Moderate positive correlation - some evidence against decoupling
Belgium	PackagingRecycling vs ElectronicsRecycling	-0.111385667	0.74438974	-0.0825137	0.74348430 2	No	Weak negative correlation between recycling types
Germany	DMC vs PackagingRecycling	0.894675058	0.00020043	0.7839294 96	0.00154130 5	Yes	Strong positive correlation - strong evidence against decoupling
Germany	DMC vs ElectronicsRecycling	-0.579184379	0.06187517 6	-0.4221158 82	0.0881579 35	No	Moderate negative correlation - some decoupling evidence
Germany	PackagingRecycling vs ElectronicsRecycling	-0.529268293	0.0940870 8	-0.4	0.1285342 23	No	Moderate negative correlation between recycling types
Denma	DMC vs PackagingRecyclin	-0.51298	0.1065908	-0.3113	0.1992219	No	Moderate negative correlation - some

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rk	g	9176	02	99578	99		decoupling evidence
Denmark	DMC vs ElectronicsRecycling	-0.35948136	0.27756192 7	-0.26696952 5	0.26738262 8	No	Moderate negative correlation - some decoupling evidence
Denmark	PackagingRecycling vs ElectronicsRecycling	0.619428618	0.04210975 5	0.51031036 3	0.04144273 4	Yes	Moderate positive correlation between recycling types

Source: Created by author

Table number 3 show all the necessary data tests that was conducted based on non-parametric nature of this paper. That is the table is informative.

Table Number (4): Showing MEAN – Median – Min – Max – Std (Descriptive Summary)

Country	Metric	Mean	Median	Min	Max	Std	First_Year	Last_Year	Change	Pct_Change
Austria	DMC	17.904272 73	17.844	17.073	18.602	0.452719359	18.602	17.073	-1.529	-8.219546285
Austria	PackagingRecycling	0.658181818	0.658	0.637	0.671	0.009652131	0.65	0.637	-0.013	-2
Austria	Electronics Recycling	0.81	0.81	0.79	0.84	0.017888544	0.79	0.84	0.05	6.329113924
Belgium	DMC	12.777181 82	12.937	11.63	13.439	0.557581172	13.439	12.768	-0.671	-4.992931022
Belgium	PackagingRecycling	0.809090909	0.8	0.78	0.85	0.020225996	0.8	0.8	0	0
Belgium	Electronics Recycling	0.743636364	0.73	0.7	0.79	0.030421284	0.79	0.73	-0.06	-7.594936709
Germany	DMC	15.015090 91	15.293	13.644	15.923	0.80142092	15.876	13.644	-2.232	-14.05895692
Germany	PackagingRecycling	0.689090909	0.69	0.64	0.71	0.02071451	0.71	0.68	-0.03	-4.225352113
Germany	Electronics Recycling	0.840909091	0.85	0.79	0.86	0.0221154	0.82	0.85	0.03	3.658536585
Denmark	DMC	23.599	23.555	22.147	25.217	0.941005951	23.555	25.217	1.662	7.055826788
Denmark	PackagingRecycling	0.689090909	0.68	0.61	0.79	0.046142073	0.61	0.68	0.07	11.475400984
Den	Electronics	0.82727	0.83	0.7	0.8	0.0205	0.82	0.82	0	0

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mark	Recycling	2727	9	6	38213

Source: Created by author

Key finding in table number 4: It shows that Denmark has highest material consumption (DMC: 23.6) and the lowest one is Belgium with (DMC: 12.8). The leading country in packaging recycling of (80.9%) is Belgium. And Germany and Austria are on the same page at around 69%. The highest reduction of DMC was achieved by Germany which is (-14.1%) while Denmark's increased (+7.1%). As for electronics recycling all countries are on the high side. Lastly Denmark improved packaging recycling significantly (+11.5%).

Table Number (5): Statistical Trend Analysis Summary

Country	Variable	Trend	P_Value	Stat_Value	Significant	Slope
Austria	DMC	no trend	0.24656	-0.381818182	No	-0.067154545
Austria	PackagingRecycling	no trend	0.392136	-0.28701669	No	-0.001009091
Austria	ElectronicsRecycling	increasing	0.003733	0.791081104	Yes	0.004363636
Belgium	DMC	decreasing	0.001789	-0.824603506	Yes	-0.122554545
Belgium	PackagingRecycling	no trend	0.869873	-0.056096819	No	9.09091E-05
Belgium	ElectronicsRecycling	decreasing	0.011836	-0.723571455	Yes	-0.007363636
Germany	DMC	decreasing	3.97E-05	-0.927272727	Yes	-0.227472727
Germany	PackagingRecycling	decreasing	0.00056	-0.866422161	Yes	-0.004363636
Germany	ElectronicsRecycling	increasing	0.014164	0.71103123	Yes	0.004363636
Denmark	DMC	increasing	0.006233	0.763636364	Yes	0.224681818
Denmark	PackagingRecycling	no trend	0.472464	-0.242503974	No	-9.09091E-05
Denmark	ElectronicsRecycling	no trend	0.606515	-0.175131944	No	-0.001545455

Source: Created by author

Key Findings of Table number five:

Germany with ($p<0.0001$, slope=-0.23) is strongest decreasing country when it comes to DMC trend. This indicates a significant improvement in reducing material consumption. Followed by Denmark with ($p=0.006$, slope=+0.22). Thirdly comes Belgium with ($p=0.002$, slope=-0.12). The impressive

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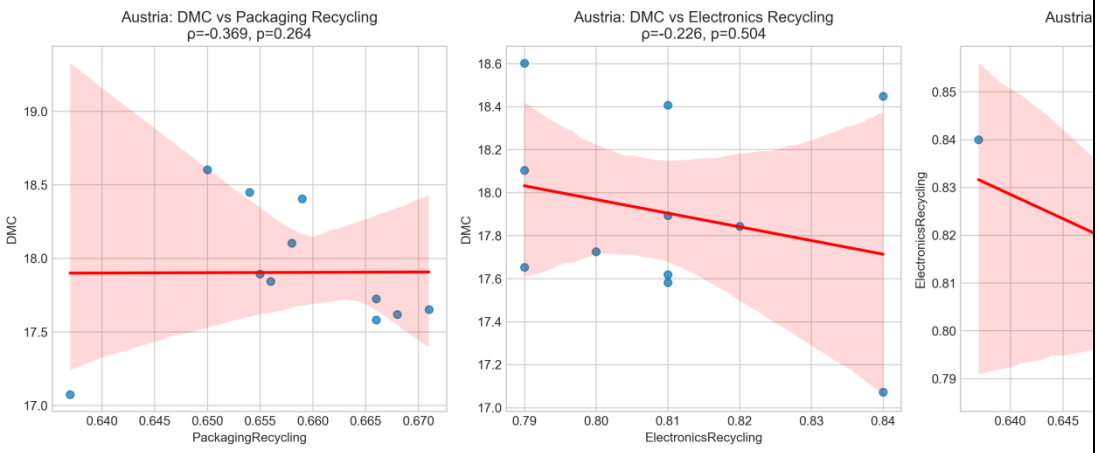
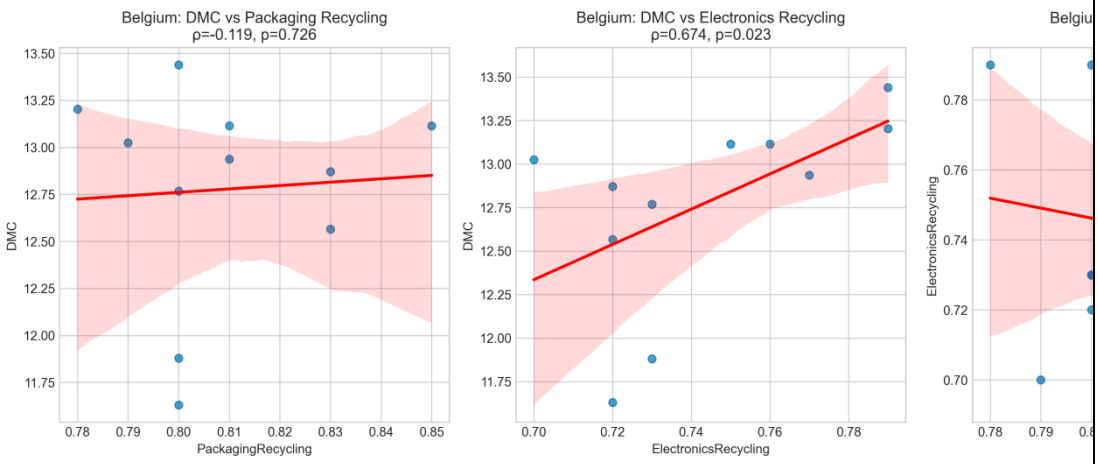
part is that Austria and Germany both are showing statistically significant increase in electronics recycling trends with values of (p<0.05, slope=+0.004). Data shows in Austria, Belgium, and Denmark packaging recycling shows no significant trend.

Table Number (6): Correlations Plots of variables of the study

Austria	
	The p-values suggest that none of these relationships are statistically significant (as they are all greater than 0.05). Meaning there is no correlation between study variables.
Belgium	
	The plot in the middle of Belgium shows statistically significant positive relationship between DMC and Electronics Recycling with p=0.023.

Source: Created by author

Table Number (7): Correlations Plots of variables of the study

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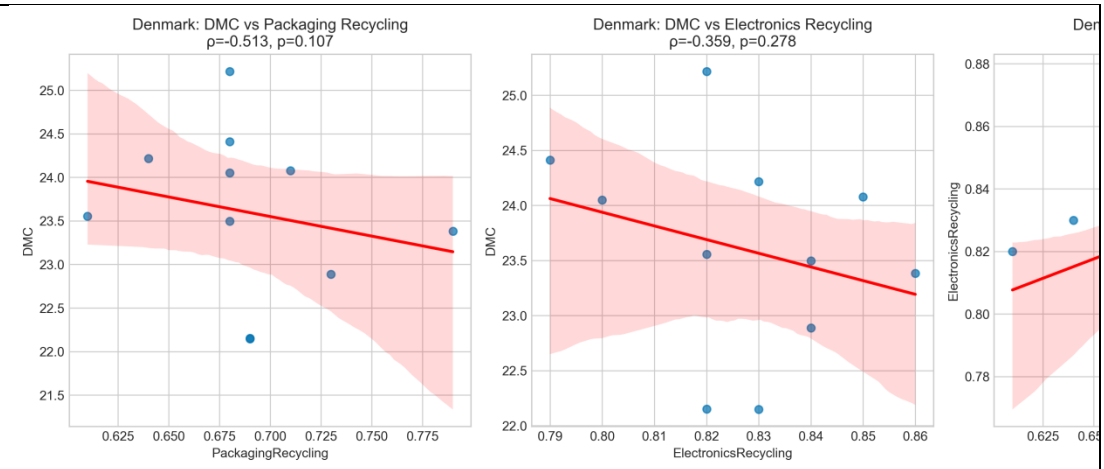
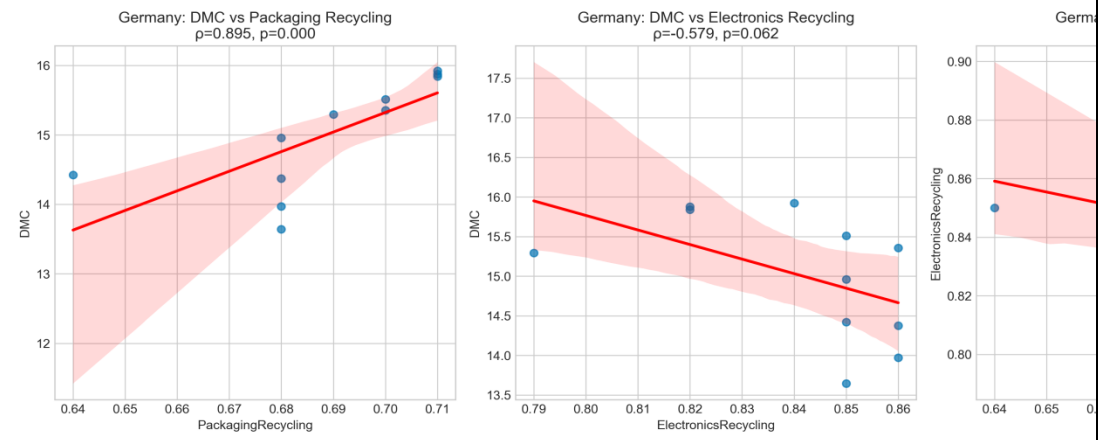
Denmark	 The first plot from right side shows a statistically significant positive relationship between Packaging Recycling and Electronics Recycling with p=0.042 This means as packaging recycling rates increases, electronics recycling also increase.
Germany	 The first plot from the left plot shows a high statistically positive relationship between DMC and Packaging Recycling with a p=0.000 and with a very strong correlation (p=0.895).

Source: Created by author

Table Number (8): Decoupling Status by Trend Direction for Denmark – Austria – Belgium - Germany

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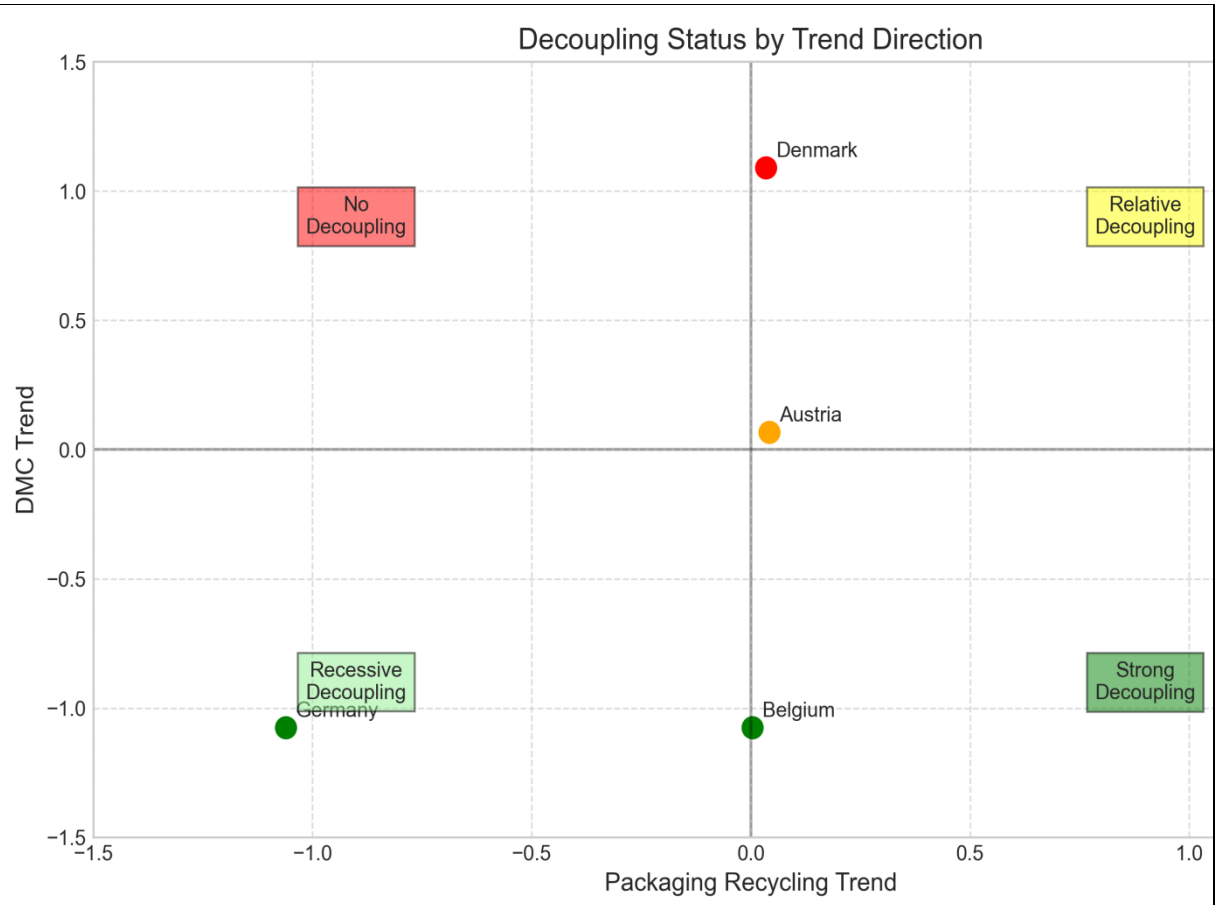

Source: Created by author

Denmark (Red Dot): Located in the positive-positive quadrant, showing no decoupling.

Austria (Orange Dot): Near the origin, showing very little change in either metric.

Belgium (Green Dot): In the bottom-right quadrant, showing strong decoupling.

Germany (Green Dot): In the bottom-left quadrant, showing recessive decoupling.

Recommendations for Further Research:

1. Expand the analysis to include more countries with varying levels of circular economy implementation.

2. Include economic growth indicators (GDP) to analyze true decoupling of economic growth from resource use.

3. Incorporate policy implementation timelines to better understand cause-effect relationships.

4. Consider additional circular economy metrics beyond recycling rates.

5. Explore other environmental indicators such as carbon emissions or waste generation rates.

Conclusion:

This research of material consumption and recycling performance reveals a crucial conclusion regarding circular economy implementation. The results and findings of this paper are showing marked differences in decoupling status across countries of this study. The articulation of this nuanced interplay between recycling and consumption in a country's economy was shown as well. In

country with strong decoupling, we saw that it was reached by some nations with reduced material consumption at the same time remained neutral in packaging recycling. Another country was recessive in decoupling as observed revealing that both consumption and packaging recycling declined but electronics recycling increased. In country with weak decoupling, we saw slight changes in metrics as noted. And other case showed no distinct decoupling pattern when there was an increase in consumption regardless of recycling. This paper has demonstrated that an increase in recycling rates do not ensure decreased consumption of materials. It is suggested as per the countries used for this paper, there is a correlation where more developed recycling infrastructure leads to higher material throughput, rather than crude resource reduction. The conflicting behavior in achieving strong decoupling without noteworthy recycling efforts showcases the need for more holistic consumption patterns and governance beyond recycling-focused frameworks.

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